

April 22, 2016

This is not a direct solicitation for anything, just sharing some thoughts on energy technology and direction. With no attempt to tone down the language, what a relief.

To cut to the quick.

- Energy is the thread that binds everything. Development and delivery of new sources, achieving them *first* and *best* for ourselves and the world, may be the only remaining method of non-fiat wealth creation left to the United States in our time.
- Any nation not self-sufficient in energy is on borrowed time. We are experiencing the twilight of the petrodollar as reserve currency and an oil price war that is surely intended to result in the bankruptcy of domestic producers and service industries, or mass acquisition of their stock and control by foreign interests. End-game tactics, and those fronting them have pushed up the timetable.
- We are also seeing twilight of *domestic manufacture* and *infrastructure* as factories shut and the great works built in the time of Roosevelt and Eisenhower come of age. The country that showed the world how to construct a modern society is falling into disrepair and decay— even as it imagines itself *prosperous*.
- We are still in the throes of a horrible nightmare that began on March 28, 1979 with the announcement of the *Three Mile Island* nuclear mishap, as the film *China Syndrome* was playing in theaters. Fear and Cold War angst led to public disenfranchisement of nuclear energy, though it was a setback that would not have deterred human progress in the space program or any previous era. So much time lost! We must correct it and awaken from the dream in double-time, or ultimately perish as a sovereign nation.
- Energy is the catalyst of our modern life, as substantial as any physical product. Cheap base load electricity delivered by grid is the running water of the industrial age. Its effect on quality of life and economic health has been analogous to the effect of clean drinking water on public health. In ages past motive power from coal directly transformed society, but in the last century *we* perfected the distribution of electricity and demonstrated the wire as the ultimate energy railway and pipeline. So we made the grids and they made *us*. Grids energized by coal, nuclear and increasingly natural gas, which has overtaken nuclear generation since 2006.
- The idea that Wind or Solar or *any* weather-intermittent energy source could meaningfully sustain an industrialized world power is a poisonous and dangerous idea, veritably an outright fraud. It should have been *laughed out of the room* years ago. Why it cannot fulfill its promise and why it was not laughed off is complicated, yet this would not have been as serious a problem if nuclear energy had made good stride up to now. We would have a *real option* on the table.
- Years ago I became convinced that our grid should grow to become 500% nuclear. The silly percentage is not hyperbole; it is an arbitrary guess as to what we may need to scale beyond present consumption in order to supplant petroleum in most things, and do new things. Call it *my green dream*. In my dream

we are using nuclear electricity for all ground transportation and a renaissance of electric rail. To support air and sea travel and feed hydrocarbon chemistry we are manufacturing the synthetic fuel, fertilizer and plastics that are now by-products of natural petroleum and methane — by processes which are known today, though they are laughably energy-intensive and inefficient. Even ludicrous ideas like purifying seawater and pumping it upstream or importing fresh water from the far North to restore depleted aquifers. But in my dream no one is laughing because there is such a *grand surplus of available energy* these things can be done 'right' with careful engineering and calm deliberation.

- I had decided on this 500% figure *despite* the known risks inherent when uranium fission heats water to drive turbines... steam and hydrogen separated from water want to explode. But we have also been witness to other grim realities and nightmares. There have been and would be wars of hegemony over petroleum (ostensibly other things) resulting in escalation or quagmire; no rational parent has ever decided their own children deserve *less* infrastructure and modern convenience than they; we must help the world to attain our North American blueprint of technology by perfecting it and helping them build it; we must ignore arrogant fools who imagine that Africa needs to be managed like some National Park; ignorant fools who believe energy austerity would lead to some Medieval paradise of 7 billion people.
- Imagine my *horror* when I discovered that one of the light water reactor's inventors, Alvin Weinberg, devoted the remainder of his career to an idea he considered *essential* to humanity's survival— in 1964. It breeds abundant Thorium to fissile U-233 in salt solution, burns almost all the fuel as opposed to the 0.5% used by light water reactors, operates at normal atmospheric pressure, has no potential for catastrophic failure such as Chernobyl (steam) or Fukushima (hydrogen), and produces a small volume of waste that is walk-away safe in ~300 years. Of course I mean the two-fluid Liquid Fluoride Thorium Reactor (LFTR) with active processing. But due to his unswerving focus and some embarrassment when he publicly expressed concerns over water reactor safety, Weinberg was *fired* from Oak Ridge, his career cut short, his work shelved and forgotten— in 1973.
- We've all had *what-the-flying-ass-monkey-fuck* moments. Imagine one spanning almost 40 years. We must strive to become energy self-sufficient as a nation and naturally wealthy, in perpetuity. General prosperity without welfare becomes possible only if we find a way to *reduce the personal and corporate cost of living* to heretofore unimagined levels.
- Imagine what might happen if the cost of putting electrical energy onto the grid levels off and begins to decrease steadily over time, approaching zero until it is practically infinitesimal compared to the amount of energy produced. What could this do for our economy? The cost of heating in winter, cooling in summer, municipal water treatment, lighting, charging electric vehicles, manufacturing, and a thousand little things with ripple effects... not in the least, a renewed interest in Big Projects. All this with *no uncertainty in obtaining fuel* that is the incidental byproduct of small footprint mining operations which are profitable in their own right. Thorium energy could do this.
- The problem with free money is that it affects all the other money in a bad way. I may be a dreamer, but I do not see the same problem with almost-free energy. I see a revitalized money economy where all things that are technically possible, even fantastic things, become more *feasible* because human ingenuity is ever-increasing. I see reduction in cost of living, cost of manufacture and cost of fossil fuel extraction that is so pervasive *its positive effect may exceed any economic strategy ever devised*. And on that day far in the future when the last hydrocarbon is extracted, it will be just cause for a quiet celebration. We'll already be well into the next great thing.
- What would the future hold, and what wonders could we achieve— if energy was simply not an issue?

The road not taken.

My father is fond of asking, *Why did we put a man on the Moon before we put wheels on luggage?*

Some day in the future I hope that someone's dad will be able to make light of these 40 years of road not taken, because we found it in time. Time and money misspent has passed by and the entire middle class (of which I was once a member) seems lost as a thread of progress stalled—one that leads directly into the largest EROEI ever achieved by human kind. We lost our way in broad daylight.

If we kept to this road I believe LFTR plants would not only be powering the entire grid today... we'd be busy finding ways to make use of their process heat such as shale oil recovery with net energy cost approaching zero, desalinization of ocean water, and co-op funded big projects of engineering. No peaks or volatility to this fuel. The only limiting factors become human *willingness* and *know-how*.

How close is it? It's easy and complicated to say. From Weinberg's experiments, including a functioning molten salt reactor (Wikipedia: Molten-Salt Reactor Experiment) that operated from 1965-69 we know the concept is proven and it is a matter of getting to prototype stage. You'd have to ask someone like Kirk Sorensen, but it may be that aside from investor sentiment a lot may depend on the Federal Government moving aside a bit, or helping.

Sorensen wants to develop it over a couple of decades. I say no, go full frontal moon-shot on this thing. Mow down the opposition by asking them to *explain a better way* convincingly, in detail. Nothing left to lose, everything to gain. Make it a national priority, the payoff is incalculable.

Weinberg was *excited* by the idea. There would be no large (potential) evacuation zones, no white-knuckled operators, no *China Syndrome*. Merely another industrial process like many others occurring securely within a building that requires ample measure of occupational safety to operate. A salt loop heated by conduction from a radioactive fissile salt loop heats inert gas to drive a closed cycle Brayton turbine. LFTR may still be practical a dozen generations from today.

Some advocates are so shell-shocked by years of attitude, investor-disinterest and anti-nuclear bias, they have simply given up and look to China and India as places where this technology is expected to mature to the commercial stage. They know that a flood of foreign patents will soon wash up on our shores to be gathered by our own government, so it can assist in restricting *our own indiscriminate use of our own* (fucking!) technology. The same technology that was kept in that file drawer at Oak Ridge all those years. They believe there will be interest in the United States only when the first units roll off the floor in China, and things will really get going.

I am hoping to find someone who might be interested before then.

Many Americans I've corresponded with seem to shrug this all off, as if it is the natural order of things. They imagine that some day LFTR will arrive from overseas like some exciting new phone or toaster, and (of course) they'll be able to afford it, and (of course) they'll trust it to be safe, and (of course) it will perform exactly as advertised, and (of course) there might be a penalty to acquire the fruit of someone else's labor, perhaps even (of course) an agreement where we purchase the power it produces rather than owning the thing itself... but hey, just add it to my bill.

We should have stayed the course and *be* the ones providing this thing that *we* invented, to the world.

LFTRs will be able to roll out of factories, as do airplanes and ships. They could be assembled from modular parts in the USA. There is no need for the single-casted steel vessel light water reactors need to ensure steam containment, now produced only one place in the world, Japan Steelworks. There is no single part that would require an extreme level of over-engineering and rigorous certification, because at normal pressure with no water, potential for explosion and massive release of radiation is simply *absent*. Many regulations on the books for 'nuclear reactors' do not even apply.

The worst-case scenario of solid fuel water reactors is pretty awful and has driven their design to the tiniest of details. It has also helped to shape the people who build and run them, who are among the finest people ever made. They are *heroes* for harnessing this energy as safely and reliably as they have done, for decades... and what has been the reward? Vilification from Hollywood and casual contempt from the public who use the energy produced. What these people deserve is a better, safer way to harness the atom so they can *relax* and get out more.

Parts and piping that come in contact with the salts must be the chromium/nickel/molybdenum Hastelloy-N specifically developed by Weinberg for this purpose, which he tested and demonstrated to have 'excellent' resistance to neutron bombardment. The beauty of Weinberg's approach is that even this *excellent* is good enough to move on the idea... for there are *no* terrifying worst-case scenarios when your reactor operates at normal atmospheric pressure. The worst case — even a bomb planted inside — is merely one of *inconvenience, expense and messy (but confined) clean-up* when you have a reactor loop which drains by gravity, goes subcritical by default and 'shuts down' when things fail. People who like to blow things up *love* natural gas. They'll hate LFTR.

Nuclear energy cannot get much better than this. Certainly not fusion, when you inquire what a unit is likely to cost, who would be required to run it and throw in the inestimable cost of waiting, doing *nothing*.

A fascinating watch.

If your precious time has already expired, thanks kindly for listening... but please *do* consider setting aside a couple of hours to watch the Thorium Remix 2011 DVD I have included.

It features Kirk Sorensen, who founded Flibe Energy and is a modern-day Johnny Appleseed of the Thorium concept as envisioned by Weinberg. While working at NASA he made a pilgrimage to Oak Ridge to 'rediscover' Weinberg's work on molten salt reactors and has helped bring it to light at the web site <http://energyfromthorium.com/>. He gathers like minds every year to the Thorium Energy Conference to jumpstart a renaissance of this research... with little result so far, certainly not the response it deserves.

"Every time mankind has been able to access a new source of energy it has led to profound societal implications. Human beings had slaves for thousands of years, and when we learned how to make carbon our slave instead of other human beings, we started to learn how to be civilized people. Thorium has a million times the energy density of a carbon-hydrogen bond. What could that mean for human civilization? Once we've learned how to use it at this kind of efficiency, we will never run out. It is simply too common."

~Kirk Sorensen in Thorium Remix 2011

Here is a time index of topics covered in the Thorium Remix DVD.

[00:00] LFTR in 5 minutes; [06:05] dialogue on Energy sources & conservation; [08:29] Elizabeth May (Green Party of Canada) on why nuclear 'fails', response; [13:40] Kirk Sorensen's time at NASA, discovering molten salt research; [17:30] on Glenn Seaborg's discovery of Thorium's fissile properties in 1942; [20:05] What nuclear fission is, decay chains, half life; [26:45] neutron absorption, cross section, Xenon poisoning at Hanford; [30:06] isotopic enrichment, Thorium/u233 rejected for weapons; [32:45] Atoms for Peace, absorption propensity and performance of nuclear fuels, thermal & fast spectrum, Thorium/Plutonium debate; [36:28] Alvin Weinberg focuses on Thorium and liquid fuels, Oak Ridge Labs, Aircraft Reactor Experiment, the Molten Salt Reactor Experiment, Fluoride Salts; [44:40] two-fluid molten salt reactor; [48:18] light water reactors, Watts Bar, reactor safety and containment systems, issues with water, Fukushima Daiichi hydrogen explosions; [01:01:38] solid fuel & rod assemblies, Eugene Wigner & liquid fuels; [01:04:38] PWR efficiency, Weinberg's quest for near-100% utilization, AEC's choice to pursue Plutonium fast breeders; [01:06:46] Weinberg's concerns about LWR safety, Congressman Chet Hollifield's inquiry, Weinberg leaves Oak Ridge, WASH-1222, Integral Fast Reactor, Traveling Wave; [01:11:26] Fusion is hard; [01:14:12] Thorium in a CANDU; [01:18:12] Colonel Paul Roege on military reactors, Robert Hargraves: prosperity is related to energy, Robert F. Kennedy on mercury from coal; [01:21:42] transuranics, LFTR active processing, electricity & isotope production from LFTR, Pu-238 and RTGs, Molybdenum-99 & Bismuth-213 in medicine; [01:27:48] cost to build LFTR; [01:30:26] proliferation concerns; [01:31:50] hysterical news coverage of radiation, LNT; [01:40:02] coal & natural gas radioactive emissions, Thorium & Uranium decay in the Earth, magnetosphere, Hargraves on CO2 emissions & ocean acidification & energy density, one-sided press coverage for 'renewables'; [01:50:07] various approaches to nuclear power, the 'reason why not' (LFTR), LWR business model; [01:54:40] China and LFTR, Sorensen's visit to Oak Ridge to obtain access to LFTR documents, the Chinese visit Oak Ridge; [01:58:01] Thorium and rare earths, China's domination of rare earths market, China's LFTR program; [02:06:39] transitioning energy sources, without plentiful energy we will revert to slavery, energy cheaper than from coal; [02:10:44] process heat applications, desalinization, synfuels, Brayton Cycle, managing transuranics, gas & oil working against nuclear, closing remarks and recap.

Of special interest is the section on rare earths [01:58:01] and China's strategy to attract manufacture using them as leverage. Clearly our mining policy has taken us to the cleaners and some redress is in order. Look into *S.2006, The National Rare Earth Cooperative Act of 2014 (Sen. Roy Blunt R-MO)* presently in the Senate Committee on Energy and Natural Resources. It aims to remove barriers to rare earth mining to break China's strangle-hold, but also contains provisions for managing Thorium which is a by-product of such mining — to encourage a renaissance of Thorium research. It's even a National Security thing.

A dusty book.

As Dr. Sorensen tells it, he learned the details of these molten salt experiments some years past from a dusty old book. Imagine that. You make your way through the modern world with a sense of confidence that everything that is *worth* knowing is part of the curriculum you have been taught — or at least, there are experts out there young like yourself, who grasp these things fully. Some one somewhere is on-task. And surely there is an investor or two behind it. And then one day you open this dusty yellowed book and start to glimpse a future, a great future, that should have been but never was.

You're asking yourself... why? And you research it further to discover that the rest of the story is kept in a file cabinet at Oak Ridge, and of those who did this work few now survive, they are in their 80s and 90s. You seek them out to discover that they are *still* convinced theirs was the best approach. They are bitter that the road was not taken.

If this quest had happened to me it would be a moving, even shocking experience. It would shake all confidence that our survival as a species was in any way 'assured'. It would coalesce into a keen sense of desperation to carry on this work, to realize the dream Weinberg laid out. That is where Sorensen is, and he tells the story so well I experience a touch of it myself, which is why I write these letters.

The United States has shown the world what it means to have access to abundant energy and surplus income: property, personal transportation, washing machines, treated water and sewage, road trips, stocked supermarkets— and yet— nothing presently "made in America" could prevent its decline. Not only have most of its factories closed, the basic blueprint for every consumer item and industrial process which supports the modern lifestyle is shared throughout the world. And China has all the blueprints.

For a price, China is now fully equipped to build an *America* anywhere in the world it chooses. From land surveying to road building to farm machinery to industrial process and infrastructure, electricity plants and grids, telecommunications, water distribution and treatment. Everything from rivets to houses, the mailbox, the picket fence and the white paint. *Everything*. And why wouldn't they? China has begun taking steps to decouple their economy from our own.

And China is working on LFTR. A delegation visited Oak Ridge Labs and patiently toured their presentation of modern wonders, and then Dr. Jiang Mianheng PhD, the son of Former Premier of China Jiang Zemin, said, *"We're actually here to learn about the molten salt reactor. We're going to build one, we've already got a site picked out, we're going to have it built by 2020 and we are here to learn everything we can about it."*

Meanwhile, the United States is parlaying with Malthusian global governance artists who seize on theories of environmental catastrophe and leverage 'affluence guilt' to tax everyone and push Wind and Solar with an eye to completely subvert coal in (unspoken, perhaps merely ignorant) promotion of natural gas... which will destroy the last remnant of our once great steel industry. I am sure you have read measured explanations of this phenomenon but not here, I have completely lost it and hold these morons in plain contempt, wishing more would do the same. The push for so-called 'renewables' has gone from obscene to downright surreal.

Rise of the math-challenged utopians.

Solar and wind farm utopias, spiced with the promise of "fusion just around the corner" and "grid-level storage" are *little green lollipops for environmentalists to suck on*. So says my father. And they do suck.

Who would come out in favor of taking our critical base load electricity generation out of a few multi-gigawatt-weather-hardened buildings, and dispersing it all over the landscape? Raising an impossible number of wind turbines on giant stalks, with millions of foreign-made precision moving parts out in the elements, supposed to last 30 years but fail within 10, all waiting for a single continent-wide ice storm and hard freeze lasting for weeks? Or any single natural event that would be a grid down overnight slate-wiper to our civilization?

Who would come out in favor of so-called 'base load solar', where acres of solar panels or reflectors are placed to gather a tormented bell curve of solar energy that dips with clouds, failure to clean, or that ice storm slate-wiper?

Why is 'grid level storage' being considered as a solution to anything? After the ice storm that paralyzes wind and solar infrastructure, how would a few hours (or days) of energy storage help? These ideas are fun. But every penny spent to implement these 'solutions' has been *squandered*. Time has been *wasted*.

We must take steps to preserve modern civilization, not just enjoy it while it lasts. We must plan for depletion of accessible petroleum, ice storms, global volcanic or asteroid impact events, solar minimums, and strife from the known and unknown. Are we prepared?

Utility wind and solar must end, now and utterly. If engineers entrusted to advise decision-makers get behind crap-solutions because they're afraid to upset people, they're not engineers. They're *bad politicians*.

Rise of the impractical physicists.

Fusion...! It should be ashamed of itself, leading us on so. We have an international cadre of scientists working on the problem who are *so clever*, they decided it is someone else's job to give direct, actionable answers to questions of what their technology could deliver and when. It saddens me to *resent* fusion, but everything the Church of Environmentalism touches turns to *shit*.

Just as the Vatican had astronomers in Galileo's time, this church supports its own esoteric nuclear magii — the chosen ones in particle physics who pursue Specifically Fusion Not Fission. Like the Holy Grail it is always around the corner, just beyond the bend. Never mind that fusion is *hard* and fission is *easy* in its fundamentals... and compared to fission which is essentially plumbing at this point, practical commercial application of fusion is [insert random number] years away. With a little blind faith one can dismiss the ever-present threat that humanity might bog down in its hydrocarbon woe and might not even survive in recognizable form until the Grail is found. The Church of Environmentalism has granted this indulgence to Fusion, and it has permitted eco-people to discuss it, to prove to the world they are not afraid of nuclear energy.

A practical physicist might run the numbers and decide *Hey! This is ridiculous. Coal and petroleum are becoming obnoxious! We need to perfect fission and get it on-line first! My degree will help. Perhaps I should too.* The world is full of impractical physicists.

We must finish taming fire.

It is no longer enough to raise sensible children without an irrational fear of nuclear energy. They must become aware at a young age that there is a silent war on and they must, in order to ensure the continued survival of modern civilization, begin to oppose and publicly ridicule anyone exhibiting this fear. This may range from a gentle instruction and chiding of those who express misgivings honestly and openly, to a direct and aggressive attack on the greatest dangers of our time — the ones who deliberately cloak their anti-nuclear sentiment in Byzantine ways intended to derail debate and parry the subject to other 'alternative' approaches.

It is *unethical* to see no clear path to unbounded Energy as anything but an existential threat.

Sound familiar? That is similar to the tactic fronted by frenetic climate alarmists who are trying to push a dozen pet agendas and several for-profit agendas crafted specially for them, all at once — rallying the people over a global average temperature signal that is presently buried in noise, and a CO₂-to-temperature causation that may turn out to be nil or even backwards. Unfortunately there is an international *scam* in progress and the scammers are clever, they have seized the moral high-ground because it had been left *unoccupied and undefended*. Those who praise humanity and progress for its own sake, and would remind others we should never judge ourselves in haste, must have wandered off somewhere.

There is also a scuffle on the Global Warming moral high-ground as the folks who run nuclear power plants are kicked in the face and tossed off the mound. They expected to be welcomed with open arms because nuclear energy *will* help save the planet from CO₂. They did not realize the movement is rife with people whose irrational fear of radiation exceeds any commitment to the environment. Anyone who even *mentions* nuclear power gets a feral and brutal response. I've taken pity on the nuclear industry and have tried to explain the phenomenon but they're not taking it very well. Like the Amish, our nuclear power industry needs staunch defenders surrounding it. They're just too polite for their own good.

Unfortunately, we have passed beyond peak politeness. To force Energy debates to address practical solutions, bullies are needed. We must rout the occupiers and re-take the moral high-ground because we place a high priority on survival, and for the children's sake. And because ... well ... *"What a piece of work is a man! How noble in reason, how infinite in faculty! In form and moving how express and admirable! In action how like an angel, in apprehension how like a god! The beauty of the world. The paragon of animals..."* And other such stuff.

To seize the game and win.

The only thing that could possibly save the United States at this juncture is to do something extraordinary—give the world a new thing of fundamental, estimable value that we would make and export. Something that changes the game for all, for the better.

Once this was hydraulic fracturing. It still is a game-changer. But that game has become rigged. Today Halliburton is gathering its rigs from all over the Midwest to park in a field in Duncan, Oklahoma a couple miles south of my house. I read recently that the Saudis have taken an interest in petroleum chemistry and wish to open factories in the UK that will use as feedstock natural gas exported from the United States. While such deals indeed reflect human progress, I recall those lofty estimates of US reserves lasting hundreds of years and wonder, how long can this volatility circus go on?

Now that thing which changes the game *could only be something like LFTR*. Like outer space for humans, it is the only place for Energy left to go. Everything else is spit-shine polish to existing ideas, scam-junk and bought time, war and occupation games, blurry fusion dreams or information technology distractions that will pop in the next bubble. Things that could *never* put real food on the table.

Nuclear waste is being discussed as if it were all extremely dangerous and there would be lots of it, by folks who have no idea of its actual volume and don't give a hoot anyway because they (conveniently, while taking a hot shower) tolerate none of it. We need to develop zero tolerance for such attitudes. There is no such thing as nuclear waste, only unburnt fuel.

We can, and have built, fast-spectrum reactors (Wikipedia: Fast-neutron reactor) which can reduce the worst nuclear waste from legacy nuclear plants to a much smaller volume that is safe within a few centuries. It is not cheap but the problem is expensive. Why are we not operating one for that purpose, today? Come to think of it, why has anyone *ever* proposed storage of nuclear waste for hundreds of thousands of years as if that was the only option? Ask the public and you may receive this uninformed answer. Perhaps they learned it from uninformed experts.

LFTR is Weinberg's attempt to design a reactor that does *not* breed that long-lived waste. He succeeded. ~300 year storage is *do-able*. Let's take a shortcut to the end-game. If we do not, some day the lights may go out, sooner than anyone thought. *Shit happens*.

From whence will come the investors, the capital, the money? Who knows. Never understood what motivates them. I am oddly speechless. So I will just write my letters, send them out and sit on the beach scanning the horizon for ships. One thing's for damned sure, we need to finish taming fire.

It's becoming *embarrassing*.

Thank you all kindly for listening.